# Survival Analysis On the Rate of Hypertension in Kwara State, Nigeria

**[1] Adeoye .A.O , [2]Aiyelabegan A.B, [3]Olatinwo ,M & [4]Sanni .B**
[1,3,4]Department of Statistics Federal Polytechnic Offa, Kwara State, Nigeria
[2]Department of Statistics, Kwara State Polytechnic, Ilorin Kwara State, Nigeria

## ABSTRACT

This research work aim to develop a model for patient with hypertension, to determine the contribution of some factors affecting the survival of hypertension and to evaluate the predictive accuracy of the model. The data used for this research was obtained from the University of Ilorin Teaching Hospital for a period of 2007-2017.Logistic regression was use to analyze the data using SPSS. From the data obtained the predictors are patient Age, Gender, Length of stay, Season and Referral status. Result from the analysis gives the model to be Y= 2.694-0.063(Gender)-0.028(Age)-0.006(Length of stay) + 0.512(Referral)-0.249(Season). From the analysis it was discovered that patient Age is the only predictor that significantly contribute to the survival of hypertension. Also the analysis shows that as the patient grow older, the chance of survival is minimal. We thereby recommend that people should go for test at early stage to determine the chance of having hypertension, because if it is not detected at early stage the chance of survival becomes low.

**Keywords**: Survival, Model, Patient, Hypertension, Kwara State, Nigeria

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## 1. INTRODUCTION

In order to get a grip about hypertension or high blood pressure, it is very important to understand what blood pressure (BP) is. It could be said that, blood is carried from the heart to all parts of the body in blood vessels. Each time the heart beats, it pumps blood into the vessels. BP is created by the force of blood pushing against the walls of blood vessels (arteries) as it is pumped by the heart (WHO, 2013). There are many definitions of hypertension However, the definitions proposed by (JNC VII, 2003) and WHO two popular definitions that are being used are. According to WHO (2013), hypertension was defined as a systolic BP equal to or above 140 mmHg and/ or diastolic BP equal to or above 90 mmHg. JNC VII has proposed another definition of hypertension. This definition might be clearer than the definition of WHO because of the classification of BP. According to JNC VII, hypertension was defined as systolic BP level of ≥ 140 mmHg and diastolic BP of ≥ 90 mmHg.

The JNC VII defined normal BP as a systolic BP < 120 mmHg and diastolic BP < 80mmHg. The area between systolic BP of 120-139 mmHg and diastolic BP of 80-89 mmHg is defined as “prehypertension” (JNC VII, 2003) Hypertension, also known as high or raised blood pressure (BP) is a global public health challenge Hypertension is a chronic medical condition in which the BP in the arteries is elevated. The higher the pressure in blood vessels the harder the heart has to work in order to pump blood, thus making the heart to work too hard. It is popularly known as the “silent killer,” because it has no specific sign and Symptoms in the initial stage.Hypertension is the most important modifiable risk factor for cardiovascular disease. Hypertension cuts across every social class. Both lower-income groups and higher-income groups may be at increased risk of developing hypertension. The etiology of hypertension is multifactorial. Aside genetic factors, several behavioral and socioeconomic factors can put an individual at risk.

Metabolic risk factors like obesity, diabetes and raised blood lipids, can also contribute to the development of hypertension and its complications. Lifestyle modification is very important for the prevention and management of hypertension. According to the World Health Organization (WHO), the prevalence of hypertension is highest in the African Region at 46% of adults aged 25 years and above, while the lowest was found in the American region. High prevalence of hypertension has been reported in some recent studies conducted in Nigeria. Hypertension is the most common non communicable disease in Nigeria. Hypertension and its complications constitute approximately 25% of emergency medical admissions in urban hospitals in Nigeria. It is the most frequently diagnosed cardiovascular disorder in Nigeria.

Hypertension is rarely accompanied by any symptom and its identification is usually through screening, or when seeking healthcare for an unrelated problem. Screening, ideally not only detects hypertension, but also the basis for education and therapy. The Country's statistics on hypertension are unreliable; "most data are outdated speculation based on mathematical models and surveys that are scanty and unrepresentative with low validity, this makes it necessary to conduct surveys that will generate reliable data that will inform decision-making at the appropriate levels of government. A prevalence rate is an important tool for assessing the magnitude and burden of a health event. Determining the prevalence of hypertension will help estimate its magnitude in the community. The prevalence rate found can also be compared with that of other community-based studies.

**High Blood Pressure Statistics**

What follows are HBP statistics

1. Normal blood pressure is below **120** systolic and below **80** diastolic
2. Prehypertension is **120-139** systolic or **80-89** diastolic
3. Stage 1 high blood pressure (hypertension) is **140-159** systolic or **90-99** diastolic
4. Stage 2 high blood pressure (hypertension) is **160** or higher systolic or **100** or higher diastolic
5. Hypertensive crisis (a medical emergency) is when blood pressure is above **180** systolic or above **110** diastolic.

**Causes of Hypertension**

It is not always clear what causes high blood pressure, but several factors and conditions may increase the chances of having it. You can have high blood pressure if you are:

1. Eating too much salt in your diet
2. Not doing exercise and other physical activity
3. Overweight or obese
4. Not eat enough fruit and vegetables
5. Smoking
6. Taking too much alcohol

Underlying condition could also trigger hypertension or cause it. This type of high blood pressure is called secondary hypertension, it tends to appear suddenly and cause higher blood pressure than does primary hypertension. Condition such as these:

- Genetics (Family history of high blood pressure)
- Kidney problems
- Older age
- Stress
- Sleep apnea (not enough sleep or have disturbed sleep)
- Thyroid problems
- Taking certain medications, such as birth control pills, cold remedies, over-the-counter pain relievers.

**Signs/ Symptoms of Hypertension**

High blood pressure is generally a chronic condition and is often associated with few or no symptoms. Hypertension may not produce any symptoms, even if you have had it for years. That's why it is sometimes referred to as a "silent killer. It is usually when blood pressure spikes suddenly and extremely enough to be considered as Hypertensive Crisis

**The Symptoms of Hypertensive Crisis**

As mentioned above, only when blood pressure readings 180 systolic and below 110 diastolic. That is when the symptoms could occur. Blood pressure this high is known as hypertensive crisis and emergency medical treatment is needed.

When the reading is high person in hypertensive crisis may experience:

(iii) Nosebleeds
(iv) Severe headaches
(v) Severe anxiety
(vi) Shortness of breath

**Blood Pressure Measurements Fall Into Four General Categories:**

*Category 1*: Normal blood pressure. If your blood pressure is below 120/80 mm Hg, then your blood pressure is normal.

*Category 2*: Prehypertension. When it ranges from 120 to 139 mm Hg or a diastolic pressure ranging from 80 to 89 mm Hg then it means you have prehypertension, which is a systolic pressure. Prehypertension tends to get worse overtime

*Category 3*: Stage 1 Hypertension. Stage 1 hypertension is a systolic pressure ranging from 140 to 159 mm Hg or a diastolic pressure ranging from 90 to 99 mm Hg.

Category 4: Stage 2 Hypertension. More severe hypertension, stage 2 hypertension is a systolic pressure of 160/180 mm Hg or higher or a diastolic pressure of 100 m/110mHg.

**How To Prevent Hypertension**

By living a healthy lifestyle, you can help keep your blood pressure in a healthy range and lower your risk for heart disease and stroke.

- Comply with medication prescriptions
- Eating a healthy diet
- Exercise regularly
- Monitor your BP
- Maintain a healthy weight
- Manage stress
- Quit smoking( cigerret,tobacco,Marjuana ...)
- Reducing your salt intake
- Stop drinking alcohol
- Understand hot tub safety

### 1.1 Statement of Problem

Hypertension is a chronic disease affecting various age groups, economic class and cutting across gender, it is pertinent to understand the prevalent factors affecting patients chance of survival of hypertension, the research is carried out to understand the probability or chance of survival of hypertension in university of Ilorin teaching hospital.

### 1.2 Scope Of The Study

The research work would cover hypertensive patients from the University of Ilorin teaching hospital recorded from 2007-2017, secondary data would be collected from the hospital and logistic regression analysis would be carried out to understand the probability of surviving hypertension.

## 2. LITERATURE REVIEW

Hypertension or high blood pressure is a worldwide problem that affects approximately 15-20% of all adults (Wang et al., 2008). Hypertension known as silent killer as it showed no symptom. Even though it is simple to diagnose and usually can be controlled by healthy diet, regular exercise, medication prescribed by doctors or a combination of these, untreated hypertension will cause serious condition (Wang et al., 2008). Hypertension is one of the important public health challenges worldwide because of its high frequency and concomitant risks of cardiovascular and kidney disease. It has been identified as a leading risk factor for mortality and ranked third as a cause of disability- adjusted life-years (Ezzati et al., 2002).

Various risk factors have been associated with hypertension, including age, sex, race, physical activity, and socioeconomic class. Vast majority of cases of uncontrolled hypertension are amongst individuals more than 60 years of age (Thomas & Ramachandran, 2005). Population studies have also shown that blood pressure correlates with body mass index (BMI) and other anthropometric indices of obesity such as waist-hip ratio. In the Framingham Study, 70% of new cases of hypertension were related to excess body fat (Kotsis et al., 2005).

The reported prevalence of hypertension varies around the world, with rates as low as 5.2% in rural North India and as high as 70.7% in Poland. Blood pressure variations also exist from within communities in the same country depending upon the economic development and affluence. In economically developed countries, the prevalence of hypertension range between approximately 20 and 50% (Patricia et al., 2004). Prevalence of hypertension in the Asia-Pacific region ranges from 5 to 47% in men and from 7 to 38% in women (Lawes et al., 2004).

Hypertension is the most common cardiovascular disorder affecting approximately 1 billion people globally and accounts for approximately 7.1 million deaths annually. Some of the known risk factors for primary hypertension like age, heredity, and gender are non-modifiable. However, the majority of the other risk factors like tobacco use, alcohol use, unhealthy diet, physical inactivity, overweight and obesity can be effectively prevented (Brundtland, 2002).

## 3. RESEARCH METHODOLOGY

### Logistic Regression

This section introduces logistic regression, which is a method for modeling the dependence of a binary response variable on one or more explanatory variables. It therefore allows one to predict a discrete outcome, such as success or failure, yes/no, from a set of variables that may be continuous, discrete, dichotomous, or a mix of any of these. For the purpose of this study, both continuous and categorical explanatory variables were considered.

### Assumptions of Logistic Regression

There are fewer assumptions for logistic regression than for multiple regression and discriminant analysis, which is one reason this technique has become popular, especially in health related fields.

- Binary logistic regression assumes that the dependent or outcome variable is dichotomous.
- Secondly since logistic regression estimate the probability of an event occurring P(Y=1), it is necessary to code the dependent variable accordingly, that is the desired outcome should be coded to be one (1).
- The model should be fitted correctly; it should not be over fitted with meaningless variables included. Also it should not be under fitted with meaningful variables not included.
- Like most other statistics, that the outcomes are independent and mutually exclusive; that is, a single case can only be represented once and must be in one group or the other.
- Also the model should have little or no multicollinearity. That is independent variables are not linear function of each other.
- while logistic regression does not requires linear relationship between the dependent and independent variable, it requires that the independent variables be linearly related to the log odds of an event
- Finally logistic regression requires large samples size because maximum likelihood estimates are less powerful than ordinary least square used in estimating the unknown parameters in a linear regression model.

### The Logistic Model

To obtain the logistic model from the logistic function, we write *z* as the linear sum

$F(z) = \frac{1}{1+e^{-z}}$ ..... (1)

$Z = \alpha + \beta 1X1 + \beta 2X2 + \ldots + \beta nXn$ .....(2)

Where the X's are independent variables of interest and α and βi are constant terms representing unknown parameters, α and βi

Substituting equation (1) into (2) we obtain.

$F(z) = \frac{1}{1+e^{-(\alpha+\sum \beta ixi)}}$

For notational convenience, we will denote the probability statement as simply p(x) where x is a notation for the collection of variables Xi through Xn.

Thus, the logistic model may be written as

$P(X) = \frac{1}{1+e^{-(\alpha+\sum \beta ixi)}}$

However, since the above logistic model is non-linear, the logit transformation would be used to make it linear, this is given by

Logit P(x) = $\ln\left[\frac{P(x)}{1-P(X)}\right]$ ..... (3)

Where P(x) = $\frac{1}{1+e^{-(\alpha+\sum \beta ixi)}}$ ..... (4)

This transformation allows us to compute a number, called logit p(x), for an individual with independent variables given by x. By substituting Equation (4) into Equation (3) we obtain

$\ln\left[\frac{P(x)}{1-P(X)}\right] = \ln\left[\frac{\frac{1}{1+e^{-(\alpha+\sum \beta ixi)}}}{\frac{e^{-(\alpha+\sum \beta ixi)}}{1+e^{-(\alpha+\sum \beta ixi)}}}\right]$

$= \ln\left[e^{(\alpha+\sum \beta ixi)}\right]$

$= \alpha + \sum \beta xi$

Logit P(X) = $\alpha + \sum \beta xi$

Logit P(x) = α +β1X1 + β2X2+…+ βnXn

Thus, the logit of p(x) simplifies to the linear sum.

The quantity p(x) divided by 1-p(x), whose log value gives the logit, describes the odds for an hypertensive patient being Alive, with independent variables specified by x.

Odd of an individual X = $\frac{P(x)}{1-P(X)}$

The goal of logistic regression is to correctly predict the category of outcome for individual cases using the most parsimonious model.

**Logistic regression with a single variable**

The logistic or logit function is used to transform an 'S'-shaped curve into an approximately straight line and to change the range of the proportion from 0–1 to -∞ to +∞.

The logit function is defined as the natural logarithm (ln) of the odds of an event. That is,

Logit = $\ln\left(\frac{P(x)}{1-P(X)}\right)$

Where p is the probability of an event.

Logit P = α + βx

**Logistic regression with several explanatory variables**

We may wish to investigate how dead or alive of patients can be predicted by more than one explanatory variable. Like ordinary regression, logistic regression can be extended to incorporate more than one explanatory variable, which may be either quantitative or qualitative. For example, given that administered hypertensive patients at risk for death are influenced by predictors such as referral, age, and length of stay.

**Tests and confidence intervals for the parameters**

**The Wald statistic**

A Wald test is used to test the statistical significance of each coefficient in the model. A Wald test calculates a Z statistic, which is: $Z = \frac{\beta}{SE}$

This z value is then squared, yielding a Wald statistic with a Chi-square distribution as follows:

$Z^2 = \chi^2 = \left(\frac{\beta}{SE}\right)^2$

**Likelihood-Ratio Test**

The likelihood ratio test for a particular parameter compares the likelihood of obtaining the data when the parameter is zero (L0) with the likelihood (L1) of obtaining the data evaluated at the Maximum Likelihood Estimate (MLE) of the parameter. The test statistic is calculated as follows.

-2 × ln(likelihood Ratio) = -2 × ln(L0/Li) = -2 × (lnL0-lnLi)
It is compared with a $\chi 2$ distribution with 1 degree of freedom.

**Goodness of fit of the model**

The goodness of fit or calibration of a model measures how well the model describes the response variable. Assessing goodness of fit involves investigating how close values predicted by the model are to the observed values.

$\chi^2 = \sum \frac{(observed - expecte\ )_2}{expected}$

The test statistic is compared with a $\chi 2$ distribution where the degrees of freedom are equal to the number of categories minus the number of parameters in the logistic regression model.

**4. ANALYSIS OF DATA**

**Table1: Show the outcome of Dead and Alive**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | DEAD | 158 | 23.0 | 23.0 | 23.0 |
| | ALIVE | 528 | 77.0 | 77.0 | 100.0 |
| | Total | 686 | 100.0 | 100.0 | |

It was observed that out of 686 number of administered hypertensive patients 528(77%) were alive while 158(23%) were dead. Thus, there were more hypertensive patient alive compare to those who were dead.

**Table.2: Shows the coefficient of the model and Variables in the Equation**

**Variables in the Equation**

| | | B | S.E. | Wald | df | Sig. | Exp(B) | 95% C.I.for EXP(B) | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Lower | Upper |
| Step 1[a] | GENDER(1) | -.063 | .185 | .117 | 1 | .732 | .939 | .653 | 1.348 |
| | AGE | -.023 | .006 | 13.607 | 1 | .000 | .977 | .965 | .989 |
| | LENGTH | -.006 | .007 | .666 | 1 | .414 | .994 | .980 | 1.008 |
| | REFERRAL(1) | .512 | .448 | 1.306 | 1 | .253 | 1.668 | .694 | 4.013 |
| | SEASON(1) | -.249 | .269 | .862 | 1 | .353 | .779 | .460 | 1.319 |
| | Constant | 2.694 | .416 | 41.861 | 1 | .000 | 14.785 | | |

a. Variable(s) entered on step 1: GENDER, AGE, LENGTH, REFERRAL, SEASON.

***Fitted Model.***

The logistic regression model for predicting the likelihood of an admitted patient surviving hypertension is given by:

$\ln\left(\frac{p}{1-p}\right)$= 2.694 – 0.063(gender) – 0.023(age) – 0.006(length of stay) +0.512(referral)- 0.249(season).

The table above gives us information about the contribution of each of our predictor variables, based on the Wald test, only patient Age with a p-value 0.000, <0.05) added significantly to the model. From the coefficient(B) of each of the predictor variables it is shown that an increase in respondent age, length of stay in the hospital and season would decrease the probability of a patient surviving hypertension, the positive B(for referral) indicate patients are more likely to survive hypertension if they are using the hospital for the first time.

The above table also allow us to understand the probability of an event occurring based on a one unit change of the independent variable when other independent variables are kept constant, Considering the Exp (B) know as the odd Ratio for each predictor variables, from the table above the odd of a patient surviving hypertension is 1.668times higher for patient using the hospital for the first time.

Patients age is also a significant predictor, the odd ratio for age is 0.977 a value <1, this implies that an increase in patient age its less likely for him/she to survive hypertension.

**Table 3: Shows the Classification Table of Dead and Alive**

**Classification Table[a,b]**

| | Observed | | Predicted | | |
|---|---|---|---|---|---|
| | | | OUTCOME | | Percentage Correct |
| | | | DEAD | ALIVE | |
| Step 0 | OUTCOME | DEAD | 0 | 158 | .0 |
| | | ALIVE | 0 | 528 | 100.0 |
| | Overall Percentage | | | | 77.0 |

a. Constant is included in the model.

b. The cut value is 0.500

In the classification table above, the overall percentage of correctly classified cases is 77.0%. In this case, spss classified that all cases (patients) diagnosed with hypertension would be alive (only because there was a higher percentage of patients who survived hypertension.

**Table 4 : Shows the result of Omnibus Tests of Model Coefficients**
**Omnibus Tests of Model Coefficients**

| | | Chi-square | df | Sig. |
|---|---|---|---|---|
| Step 1 | Step | 16.826 | 4 | .002 |
| | Block | 16.826 | 4 | .002 |
| | Model | 16.826 | 4 | .002 |

The omnibus test of model coefficient gives us the overall indication of how well the model performed, over the above result obtained in block 0, with none of the predictors entered into the model. The deduction from the goodness of fit test is that the model with our predictor variables is better than spss original guessed in Block 0,
A p-value (0.002)< 0.05 means the model with our predictors is better than spss originally guessed in block 0 which assumes that everyone will survive hypertension with a chi-square value of 16.826 with degree of freedom(df) 4.

**Table 5: Show the result of Hosmer and Lemeshow Test**
**Hosmer and Lemeshow Test**

| Step | Chi-square | Df | Sig. |
|---|---|---|---|
| 1 | 3.265 | 8 | .917 |

This test also support our model as been worthwhile, this test which is most reliable test of model fit in spss is interpreted differently from the omnibus test above.

For Hosmer-Lemeshow goodness of fit test, poor fit is indicated by a sig value less than 0.05 level of significance, so to support our model we actually wants a value greater than 0.05, the chi-square value for Hosmer-Lemeshow is 3.265with a sig value (0.917) greater than 0.05 therefore indicating support for our model (the inclusion of predictor variables is better ).

## 5. SUMMARY AND CONCLUSION

Binary logistic regression was used to assess the impact of some numbers of factors on the likelihood of survival of hypertension at the university of Ilorin teaching hospital. The models used contain five (5) independent variables namely (Gender, Age, Length of stay, Referral status and season). The full model containing all predictors was statistically significant with a $\chi^2$ =16.826 having a p-value 0.002<0.05 indicating the model with the predictors will be able distinguish between those likely to survive hypertension. The model obtained is Y= 2.694-0.063(Gender)-0.028(Age)-0.006(Length of stay) + 0.512(Referral)-0.249(Season). And the model correctly classify 77% of all cases as shown in table 3, and explain between 2.4% (Cox & Snell R square) and 3.7%(Nagelkerke R square) of the variability of survival of hypertensive patient which is low indicating other factors not included in the model. Only one independent variable as shown in table 2 made a unique statistically significant contribution to the model (patient age) with a p-value (0.00)<0.05.but referral status , though not statistically significant have the highest odd ratio of 1.668 indicating patient using university of Ilorin teaching hospital before are 67% sure of surviving hypertension than those that are using it for the first time .

The odd ratio of patient age 0.977<1 with a (B) indicate that for everyone year added to the age of a hypertensive patient they have 0.3% of surviving hypertension. The predictor length of stay also have a (B) with an odd ratio <1 indicating the more a patient stays in the hospital the lower their chance of surviving hypertension.We thereby recommend that people should go for test at early stage to determine the chance of having hypertension, because if it is not detected at early stage the chance of survival becomes low.

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